

# SCIENCE

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## THE CALIFORNIA EARTHQUAKE.

THREE days after the earthquake of April 18, Governor Pardee appointed a committee of inquiry consisting of Professor A. C. Lawson, of the State University; Mr. G. K. Gilbert, of the U. S. Geological Survey; Professor Fielding Reid, of Johns Hopkins University; Professor J. C. Branner, of Stanford University; Professor A. O. Leuschner, of the State University; Professor George Davidson, of the State University; Professor Charles Burkhalter, of the Chabot Observatory, and Professor William Wallace Campbell, director of the Lick Observatory. Professor Lawson was elected chairman and Professor Leuschner secretary. The results of the inquiry communicated to Governor Pardee on May 31, are as follows:

One of the remarkable features of the Coast Ranges of California is a line of peculiar geomorphic expression which extends obliquely across the entire width of the mountainous belt from Mendocino County to Riverside County. The peculiarity of the surface features along this line lies in the fact that they are not due, as nearly all the other features of the mountains are, to atmospheric and stream erosion of the uplifted mass which constitutes the mountains, but have been formed by a dislocation of the earth's crust, or rather a series of such dislocations, in time past, with a differential movement of the parts on either side of the plane of rupture. In general this line follows a system of long narrow valleys, or where it passes through wide valleys it lies close to the base of the

confining hills, and these have a very straight trend; in some places, however, it passes over mountain ridges, usually, at the divide separating the ends of two valleys; it even in some cases goes over a spur or shoulder of a mountain. Along this line are very commonly found abrupt changes in the normal slope of the valley sides giving rise to what are technically known as scarps. These scarps have the appearance of low precipitous walls which have been usually softened and rounded somewhat by the action of the weather. Small basins or ponds, many having no outlet, and some containing saline water, are of fairly frequent occurrence and they usually lie at the base of the small scarps. Trough-like depressions also occur bounded on both sides by scarps. These troughs and basins can only be explained as due to an actual subsidence of the ground or to an uplift of the ground on one side or the other, or on both sides. The scarps similarly can only be ascribed to a rupture of the earth with a relative vertical displacement along the rupture plane. Frequently small knolls or sharp little ridges are found to characterize this line and these are bounded on one side by a softened scarp and separated from the normal slope of the valley side by a line of depression. In many cases these features have been so modified and toned down by atmospheric attack that only the expert eye can recognize their abnormal character; but where their line traverses the more desert parts of the Coast Range, as for example in the Carissa Plains, they are well known to the people of the country and the aggregate of the features is commonly referred to as the 'earthquake crack.'

This line begins on the north at the mouth of Alder Creek near Point Arena and extends southeasterly nearly parallel with the coast line to a point about two miles below Fort Ross, a distance of forty-

three miles. Here it passes outside of the shore line and is again met with at the point where Bodega Head joins the mainland. Thence it appears to continue southward through Tomales Bay and Bolinas Lagoon. Beyond Bolinas Lagoon it passes outside of the Golden Gate and enters the shore again at Mussel Rock, eight miles south of the Cliff House. From this point it is traceable continuously along the valley line occupied by San Andreas and Crystal Springs Lakes, past Woodside and Portola, over a saddle back of Black Mountain, thence along Stevens Creek Cañon, passing to the southwest of Table Mountain and Congress Springs to the vicinity of Wrights, on the narrow-gauge railway between San José and Santa Cruz. From Wrights it continues on in the same course through the Santa Cruz Mountains to the point where the Southern Pacific Railway crosses the Pajaro River near Chittenden. From the crossing of the Pajaro the line extends up the valley of the San Benito River, across the eastern portion of Monterey County, and thence follows the northeastern side of the valley of the San Juan River and the Carissa Plains to the vicinity of Mount Pinos, in Ventura County. The line thus traced from Point Arena to Mount Pinos has a length of 375 miles, is remarkably straight, and cuts obliquely across the entire breadth of the Coast Ranges. To the south of Mount Pinos the line either bends to the eastward following the general curvature of the ranges or is paralleled by a similar line offset from it *en echelon*; for similar features are reported at the Tejon Pass and traceable thence though less continuously across the Mojave Desert to Cajon Pass and beyond this to San Jacinto and the southeast border of the Colorado Desert. The probability is that there are two such lines, and that the main line traced from Point Arena to Mount Pinos is continued with



the same general straight trend past San Fernando and along the base of the remarkably even fault scarp at the foot of which lies Lake Elsinore. But, leaving the southern extension of the line out of consideration as somewhat debatable, we have a very remarkable physiographic line extending from Point Arena to Mount Pinos which affords every evidence of having been in past time a rift, or line of dislocation, of the earth's crust and of recurrent differential movement along the plane of rupture. The movements which have taken place along this line extend far back into the Quaternary period, as indicated by the major, well degraded fault scarps and their associated valleys; but they have also occurred in quite recent times, as is indicated by the minor and still undegraded scarps. Probably every movement on this line produced an earthquake, the severity of which was proportionate to the amount of movement.

The cause of these movements in general terms is that stresses are generated in the earth's crust which accumulate till they exceed the strength of the rocks composing the crust and they find a relief in a sudden rupture. This establishes the plane of dislocation in the first instance, and in future movements the stresses have only to accumulate to the point of overcoming the friction on that plane and any cementation that may have been effected in the intervals between movements.

The earthquake of the eighteenth of April, 1906, was due to one of these movements. The extent of the rift upon which the movement of that date took place is at the time of writing not fully known. It is, however, known from direct field observations that it extends certainly from the mouth of Alder Creek near Point Arena to the vicinity of San Juan in San Benito County, a distance of about 185 miles. The destruction at Petrolia and Ferndale

in Humboldt County indicates that the movement on the rift extended at least as far as Cape Mendocino, though whether the rift lies inland or offshore remains as yet a matter of inquiry. Adding the inferred extension of the movement to its observed extent gives us a total length of about three hundred miles. The general trend of this line is about N. 35° W., but in Sonoma and Mendocino counties it appears to have a slight concavity to the northeast, and if this curvature be maintained in its path beneath the waters of the Pacific it would pass very close to and possibly inside of Capes Gordo and Mendocino. Along the 185 miles of this rift where movement has actually been observed the displacement has been chiefly horizontal on a nearly vertical plane, and the country to the southwest of the rift has moved northwesterly relatively to the country on the northeast of the rift. By this it is not intended to imply that the northeast side was passive and the southwest side active in the movement. Most probably the two sides moved in opposite directions. The evidence of the rupture and of the differential movement along the line of rift is very clear and unequivocal. The surface soil presents a continuous furrow generally several feet wide with transverse cracks which show very plainly the effort of torsion within the zone of the movement. All fences, roads, stream courses, pipe lines, dams, conduits and property lines which cross the rift are dislocated. The amount of dislocation varies. In several instances observed it does not exceed six feet. A more common measurement is eight to ten feet. In some cases as much as fifteen or sixteen feet of horizontal displacement has been observed, while in one case a roadway was found to have been differentially moved twenty feet. Probably the mean value for the amount of horizontal displacement along the rift line is about ten feet and the variations

from this are due to local causes such as drag of the mantle of soil upon the rocks, or the excessive movement of soft incoherent deposits. Besides this general horizontal displacement of about ten feet there is observable in Sonoma and Mendocino counties a differential vertical movement not exceeding four feet, so far as at present known, whereby the southwest side of the rift was raised relatively to the northeast side, so as to present a low scarp facing the northeast. This vertical movement diminishes to the southeast along the rift line and in San Mateo County is scarcely if at all observable. Still farther south there are suggestions that this movement may have been in the reverse direction, but this needs further field study.

As a consequence of the movement it is probable that the latitudes and longitudes of all points in the Coast Ranges have been permanently changed a few feet, and that the stations occupied by the Coast and Geodetic Survey in their triangulation work have been changed in position. It is hoped that a reoccupation of some of these stations by the Coast and Geodetic Survey may contribute data to the final estimate of the amount of movement.

The great length of the rift upon which movement has occurred makes this earthquake unique. Such length implies great depth of rupture, and the study of the question of depth will, it is believed, contribute much to current geophysical conceptions.

The time of the beginning of the earthquake as recorded in the Observatory at Berkeley was 5<sup>h</sup> 12<sup>m</sup> 6<sup>s</sup> A.M., Pacific standard time. The end of the shock was 5<sup>h</sup> 13<sup>m</sup> 11<sup>s</sup> A.M., the duration being 1<sup>m</sup> 5<sup>s</sup>. Within an hour of the main shock twelve minor shocks were observed by Mr. S. Albrecht of the Observatory and their time accurately noted. Before 6<sup>h</sup> 52<sup>m</sup> P.M. of the same day thirty-one shocks were noted

in addition to the main disturbance. These minor shocks continued for many days after April 18, and in this respect the earthquake accords in behavior with other notable earthquakes in the past. The minor shocks which succeed the main one are interpreted generally as due to subordinate adjustments of the earth's crust in the tendency to reach equilibrium after the chief movement.

The collection of time records necessarily proceeds slowly. The purpose of the coseismal curves based upon these records is in general two-fold. In ordinary earthquakes it is one of the means of locating the seat of the disturbance when there is no surface manifestation of the rupture in the earth's crust. In the present instance, however, the rupture has declared itself in an unmistakable rift observable at the surface, and coseismals are, therefore, unnecessary for the determination of this important factor in the general problem, so far at least as regards the main disturbance. It is probable, however, that so radical a change in the equilibrium of the stresses of the earth's crust would induce secondary ruptures and consequently secondary earthquakes closely associated with the chief shock. The careful plotting of the time records may, therefore, be useful in revealing the location of these secondary disturbances, such for example as the one which affected southern California on the afternoon of the eighteenth of April. The second purpose of securing time records is the determination of the velocity of propagation of the earth wave; and the data for this which are likely to be most serviceable are the records obtained at various quite distant seismographic stations.

The destructive effects of the earthquake are in the main distributed with reference to the line of rift. The exact limits of the area of destruction have not yet been mapped, but it is known to extend out



about twenty-five or possibly thirty miles on either side of the rift. On the southwest side the greater part of this area to the north of the Golden Gate lies in the Pacific. This area extends from Eureka, in Humboldt County, to the southern extremity of Fresno County, a distance of about four hundred miles.

Beyond this area of destructive shock the earthquake was felt in its milder manifestations over a wide territory. Our reports to date show that it was felt in Oregon as far north as Coos Bay and on the south as far as Los Angeles. To the east it was felt over the greater part of middle California and eastern Nevada, particularly along the eastern flank of the Sierra Nevada. It was felt at Lovelocks, and we have unconfirmed reports of its having been felt at Winnemucca. Far beyond the region within which it was apparent to the senses, however, the earth wave was propagated both through the earth and around its periphery; and some of the most valuable and most accurate records of the disturbance which we have are those which were registered at such distant seismographic stations as Washington, D. C.; Sitka, Alaska; Potsdam, Germany; and Tokyo, Japan.

Within the area of destructive effects approximately four hundred by fifty miles in extent the intensity varied greatly. There was a maximum immediately on the rift line. Water pipes, conduits and bridges crossing this line were rent asunder. Trees were uprooted and thrown to the ground in large numbers. Some trees were snapped off, leaving their stumps standing, and others were split from the roots up. Buildings and other structures were in general violently thrown and otherwise wrecked, though some escaped with but slight damage. Fissures opened in the earth and closed again, and in one case reported a cow was engulfed. A second line

of maximum destruction lies along the floor of the valley system of which the Bay of San Francisco is the most notable feature, and particularly in the Santa Rosa and Santa Clara valleys. Santa Rosa, situated twenty miles from the rift, was the most severely shaken town in the state and suffered the greatest disaster relatively to its population and extent. Healdsburg suffered to a nearly similar degree. San José, situated thirteen miles, and Agnews, about twelve miles from the rift, are next in the order of severity. Stanford University, seven miles from the rift, is probably to be placed in the same category. All of these places are situated on the valley floor and are underlain to a considerable depth by loose or but slightly coherent geological formations, and their position strongly suggests that the earth waves as propagated by such formations are much more destructive than the waves which are propagated by the firmer and highly elastic rocks of the adjoining hill lands. This suggestion is supported by a consideration of the destructive effects exhibited by towns and single buildings along the same valley line which are situated wholly or partly on rock. Petaluma and San Rafael, though nearer the rift than Santa Rosa, suffered notably less, and they are for the most part on, or close to, the rocky surface. The portions of Berkeley and Oakland which are situated on the alluvial slope suffered more than the foothills, where the buildings are founded on rock. The same suggestion is further supported from a consideration of the zone of maximum destructive effect on the southwest side of the rift. This zone lies in the Salinas Valley. The intensity of destructive action at Salinas was about the same as at San José, and the town is situated on the flood plain deposits of the Salinas River. Along the banks of the Salinas River and extending from Salinas to the vicinity of

Gonzales, so far as our reports at present show, the bottom lands were more severely ruptured, fissured and otherwise deformed than in any other portion of the state. The Spreckels Sugar Mill, situated on the banks of the river, suffered more severely probably than any other steel structure in the state. Santa Cruz, on the other hand, which is on the same side of the rift, and at the same distance from it, but which is built on rock for the most part, suffered much less damage. In the northern counties along the coast the most severe effects were felt at Ferndale, on the south margin of the flood plain of the Eel River, and at Petrolia, on the bottom land of the Mattole. Fort Bragg was severely shaken with very destructive effects, but our reports do not yet indicate the character of the ground upon which it is situated.

In the facts which have been cited we seem to have warrant for a generalization as to the excessively destructive effect of the earth wave as transmitted by the little coherent formations of the valley bottoms. But it must be borne in mind that by far the greater number of structures subject to destructive shock are situated in the valley lands and that there has not yet been time for a detailed comparison of the effects in the valleys with those in the hills, where the buildings are founded on firm rock except in a few notable instances.

The most instructive of these instances is the city of San Francisco, and the facts observed there are entirely in harmony with the generalization above outlined. In the city of San Francisco we may recognize for preliminary purposes four types of ground: (1) The rocky hill slopes; (2) the valleys between the spurs of the hills which have been filled in slowly by natural processes; (3) the sand dunes; (4) the artificially filled land on the fringe of the city. Throughout the city we have a graded scale of intensity of destructive effects

which corresponds closely to this classification of the ground. The most violent destruction of buildings, as everybody knows, was on the made ground. This ground seems to have behaved during the earthquake very much in the same way as jelly in a bowl, or as a semi-liquid material in a tank. The earth waves which pass through the highly elastic rocks swiftly with a small amplitude seem in this material to have been transformed into slow undulations of great amplitude which were excessively destructive. The filled in material and the swampy foundation upon which it rests behaved, in other words, as a mass superimposed upon the earth's surface, rather than as a part of the elastic crust itself. In a less degree the same thing is true of the sand dune areas, where the ground was frequently deformed and fissured. In still less degree the naturally filled valleys between the hill spurs were susceptible to this kind of movement, and the destruction of buildings was correspondingly less, but still severe, depending very largely on the character of the buildings, the integrity of their construction, etc. In portions of these valleys, however, the original surface of the ground has been modified by grading and filling, and on the filled areas the destruction was more thorough than elsewhere in the same valley tracts. On the rocky slopes and ridge tops, where, for the most part, the vibration communicated to buildings was that of the elastic underlying rocks, the destruction was at a minimum. On some of the hills chimneys fell very generally and walls were cracked; on others even the chimneys withstood the shock.

While this correlation of intensity of destructive effect appears to hold as a generalization, there are well known exceptions which find their explanation in the strength of the structures. Modern class A steel structures with deep foundations appear to



have been relatively passive, while the made ground in their immediate vicinity was profoundly disturbed. Thoroughly bonded and well cemented brick structures, on similarly deep and solid foundations, seem to have been equally competent to withstand the shock, except for occasional pier-like walls not well tied to the rest of the building. The weak points in wooden frame structures were in general the faulty underpinning and lack of bracing, and chimneys entirely unadapted to resist such shocks. With these faults corrected, frame buildings of honest construction would suffer little damage beyond cracking of plaster in such a shock as the eighteenth of April, save on the made ground, where deep foundations and large mass appear to be essential for the necessary degree of passivity.

Pipe lines and bridges crossing the rift line present a peculiar, if not quite unique, engineering problem which will doubtless be solved in the near future. Pipe lines on low swampy ground or in made ground are in much greater danger of destruction from earthquake shocks than those on high ground underlaid by rock, except in the immediate vicinity of the rift, where nothing could be constructed which would withstand the violence of the earth movement.

One of the lessons of the earthquake which seems peculiarly impressive is the necessity for studying carefully the site of proposed costly public buildings where large numbers of people are likely to be congregated. In so far as possible such sites should be selected on slopes upon which sound rock foundation can be reached. It is probably in large measure due to the fact of their having such a rock foundation that the buildings of the State University, at Berkeley, escaped practically uninjured. The construction of such buildings as our public schools demands the most earnest attention of the people and of the

authorities charged with their construction. A great many of our schools proved to be of flimsy construction and ill adapted to meet the emergency of an earthquake shock of even less severity than that of the eighteenth of April.

The commission in presenting this brief report has had in mind the demand on the part of the people of the state and of the world at large for reliable information as to the essential facts of the earthquake. It has, therefore, not presumed to engage in any discussion of the more abstruse geological questions which the event naturally raises. It leaves such discussion for a more exhaustive report which can only be prepared after the campaign of data collection is complete, and that may be some months hence.

Very respectfully submitted in behalf of the commission.

ANDREW C. LAWSON,  
*Chairman.*

A. O. LEUSCHNER,  
*Secretary.*

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THE ROYAL SOCIETY OF CANADA.

THE twenty-fifth annual meeting of the Royal Society of Canada was held in Ottawa, Ontario, from Tuesday to Thursday evening, May 22-24, under the presidency of Dr. Alexander Johnson, M.A., LL.D., D.C.L., emeritus professor of mathematics in McGill University, Montreal. There was a large attendance of fellows. This society, which is of a distinctive national character, comprises four sections, each numbering thirty members or fellows selected and elected from any of the provinces of the Dominion of Canada. Section I. and Section II. are more distinctively literary and historical and comprise French and English writers, while Section III. and Section IV., devoted to the mathematical, physical and chemical sciences, as well as to the geological and biological sciences,

furnish material more within the scope of the readers of SCIENCE. In Sections I. and II., however, it may not be out of place to note that there were several papers presented that are of special interest from the exploratory side of historical researches, *e. g.*, 'The Successors of de la Vérendrye under the French Régime: 1743-1755,' by the Hon. L. A. Prud'Homme, in which the successors of the first discoverer of the Rocky Mountains and their enterprises are described, and Dr. Sulte's 'General Index' to the twenty-four volumes of the Royal Society of Canada already published, will form a most valuable contribution.

Amongst sociological studies of a high order may be ranked Mons. Léon Gérin's monographs on the French Canadian habitant—two types from the southern plain of the St. Lawrence. Gérin's descriptions of the three types from the north shore of the same river are too well known to be commented upon.

Monsieur Errol Bouchette discusses the relation between social progress and primary education.

Dr. N. E. Dionne gives a chronological list of the volumes, pamphlets, newspapers and reviews published in the English tongue in the Province of Quebec from the first introduction of printing in 1764 to 1906. In a previous volume of the *Proceedings and Transactions of the Royal Society of Canada* Dionne prepared a similar and very exhaustive work for all similar writings in the French language.

In Section II. R. W. McLachlan gave a sketch of the life of Joseph Fleury Mesplet, who first introduced printing in Canada, whilst Professor W. F. Ganong, corresponding member of the society, gives further contributions to his invaluable monographs on the province of New Brunswick. Dr. S. E. Dawson has a paper 'On the Birds met with by Cartier on the North-

eastern Coast of America and especially of the Great Auk, now Extinct.'

### SECTION III. MATHEMATICS, PHYSICAL AND CHEMICAL SCIENCES.

Then come the papers and addresses delivered before the third section, with Professor Alfred Baker, of Toronto University, president of the section.

The following papers of scientific interest were presented and discussed:

Dr. E. Deville's paper, entitled 'Abacus of the Altitude and Azimuth of the Pole Star,' explains the theory and constitution of a diagram for finding, without calculation, the altitude and azimuth of the pole star when the sidereal time is known. The diagram was prepared for the use of the surveyors who have to subdivide townships in the northwest territories.

'Notes sur la Mécanique céleste, les Mathématiques, le calcul différentiel et l'Algèbre,' by Docteur Arthur Duval.

'On the Metallic Currency of the British Empire,' by Thomas Macfarlane, M.E., F.R.S.C., F.C.S., Dominion analyst.

'On the Analysis of Wheaten Flour' and 'On the Conservation of Nitrogen in Manure,' by Thomas Macfarlane, M.E., F.R.S.C., F.C.S., Dominion analyst.

Professor R. B. Owens, of McGill University, Montreal, contributed a paper 'On a New Form of Frequency Indicator.'

Mons. C. Baillargé, of Quebec, contributed no less than six papers on varied topics, including (a) 'The Simplification of Geometrical Teaching'; (b) 'The Incommensurability of the Bushel and Gallon Measures as Used in Canada'; (c) 'The Duration of the World Rationally Considered'; (d) 'The Humanitarian Question of how to Prevent Accidents to Children or Persons Taking Fire from Becoming Fatalities'; (e) 'On the Spontaneous Origin of Forest Fires'; (f) 'A Retro-



spective View—Twenty-fifth Anniversary of the Foundation of the Royal Society.'

Professor C. H. McLeod and Dr. Howard T. Barnes, both of McGill University, Montreal, contribute a joint paper entitled 'Differential Temperature Records in Meteorological Work.' This paper contains further results obtained with the electric recorder and thermometers at different levels, an account of which was presented two years ago before Section III. of the Royal Society. Much evidence has been obtained to show that the traces may be used to advantage in temperature forecasting.

'An Aluminum and Magnesium Cell,' by Mr. G. H. Cole and Dr. H. T. Barnes (McGill), describes a cell which has proved to be of some interest in its behavior on short circuit. It illustrates very well the effect of dissolved gases on metal surfaces.

'Nocturnal Radiation' was then discussed by Dr. H. T. Barnes himself, in which the following two points of special import are given: (a) Differential temperature traces have been obtained of the radiation at night from the surface of a specially prepared thermometer; (b) the effect of a clear or cloudy atmosphere is shown, and the absorption of the heat rays in some materials is given. This paper is followed by another one by Dr. Barnes on 'Radiation as the Cause of Anchor Ice Formation.' Further evidence is given in support of the view that radiation is the main cause of anchor ice formation. It is shown that water and ice are apparently transparent to the long heat rays beyond  $80\mu$ .

Mr. R. W. Boyle's two papers, namely, (a) 'The Effect of Tensile Stress on Specific Resistance' and 'Effect of an Electric Current on the Modulus of Elasticity,' introduced by Professor Barnes, reveal interesting results with the new resistance alloys, manganin, constantin and rheotin.

A few of the pure metals are also studied in comparison.

Then follow a series of further contributions to physics, entitled:

'On Deficient Humidity of the Atmosphere,' by Dr. T. A. Starkey and Dr. H. T. Barnes.

It is shown by accurate hygrometric tests that the air in an ordinary building, heated by the hot-water system, may be almost devoid of water vapor in the winter time. The ill effects of this on the respiratory tract are discussed. A comparison of various hygrometers is given.

'Mass of the  $\alpha$  Particles expelled from Radium,' by Professor E. Rutherford, F.R.S.

'Some Peculiar Effects resulting from the Distribution of the Intensity of the Radiation from Radioactive Sources,' by Professor E. Rutherford, F.R.S.

'A New Product of Actinium,' by O. Hahn, Ph.D., presented by Professor Rutherford.

'The Origin of the  $\beta$  Rays from Radioactive Substances,' by W. Levin, Ph.D., presented by Professor Rutherford.

Then follow a series of researches in physical chemistry carried out in the University of Toronto during the academic year, 1905-06, communicated by Professor W. Lash Miller.

'The Detection and Estimation of Certain of the Oxidation Products of Naphthalene,' by M. C. Boswell; 'The Mechanism of the Oxidation of Naphthalene by Nitric Acid and by Chromic Acid,' by M. C. Boswell; 'The Intermediate Compound Theory in Chemical Kinetics: the Reaction between Bromic, Hydriodic and Arsenious Acids,' by Fred. C. Bowman; 'Tautomeric Forms of the Keto-esters,' by R. H. Clark; 'The Mechanism of the Aceto-acetic-ester Synthesis,' by R. H. Clark; 'Analysis of the Reactions leading to the Formation of Phthalonic Acid from Naphthalene,' by R.

A. Daly; 'The 'Method of Effective Averages' for Dealing with the Equations of Chemical Kinetics,' by R. E. DeLury; 'Induction of the Reaction between Arsenious Acid and Chromic Acid by Hydrogen Iodide,' by R. E. DeLury; 'The Formation of Acetic Acid by the Action of Chromic Acid on Alcohol,' by C. F. Marshall; 'The Mechanics of the Reaction between Iodine and Starch,' R. B. Stewart.

And the papers of Section III. close with the following:

'Isomorphism as Illustrated by Certain Varieties of Magnetite,' by Dr. B. J. Harrington.

'An Investigation on the Value of the Indentation Test for Steel Rails,' by H. K. Dutcher, and introduced by Professor Henry T. Bovey.

#### SECTION IV. GEOLOGICAL AND BIOLOGICAL SCIENCES.

Not less than twenty-nine papers or contributions were recorded on the work of this section last week. They include the following:

'Illustrations of the Fossil Fishes of the Devonian Rocks of Canada, Part III.,' by Dr. J. F. Whiteaves.

This paper is mainly a revision of the author's previous well-known papers on the Upper and Lower Devonian fishes of Seau-mence Bay, Quebec, and of Campbellton, New Brunswick.

'The Form and Structure of Lamp-organs in Certain Fishes,' by Professor Edward E. Prince.

The author describes the minute microscopic structure of certain phosphorescents, notably those of *Maurolicus*, and is unable to support von Lendenfeld's view that clavate cells are an essential feature in them. The emission of light observed by the author, and the lamp-like arrangement of the parts of these organs (including phosphorescent adenoid material, a silvery

reflector, and a clear bull's-eye lens), all indicate the purpose of these curious structures in the deep-sea fishes referred to in the paper.

'New Points in the Structure and Development of the Pharyngeal Teeth in Fishes,' by Professor Edward E. Prince.

The author finds, from the study of sections of the pharyngeal teeth of fishes, in early stages of development, that their structure is more complex than is usually admitted. Goodsir, Tomes and other eminent authorities have described involutions of the buccal epithelium to form the external and internal enamel organ, but Balfour's surmise is correct that the whole dental sac is endodermic, at any rate in pharyngeal teeth in fishes. In each sac may be distinguished: a delicate external stratified layer or sac-well; a layer of cubical epithelial cells (the external enamel organ) which are infolded to form the internal enamel organ; and a papilla or central dental pulp. A cone of clear dentine, which is readily stained with carmine, is developed from the papilla; while the large palisade epithelium forming the inner enamel organ secretes the clear bright matter, which is determined to be enamel. Dr. J. Beard found, even in the teeth of low fishes, like *Myxine* and *Bdellostoma*, all the features referred to, recalling the details given by O. Hertwig, in Amphibian teeth. The distinctness of the inner dentine and the outer or enamel layer is so marked that Owen's view can not be accepted that all dental tissues in fishes are modifications of dentine only, and Hertwig's statement that enamel is a secretion, and not as Tomes held, transformed epithelium cells, is confirmed.

'On *Amyzon brevipinne* Cope, from the Amyzin Beds of the Southern Interior of British Columbia,' by Lawrence M. Lambe.

In this paper a description of *Amyzon brevipinne* Cope is given, based on a sec-



ond specimen of this species that the writer recognized in a small collection of fishes from the Tertiary deposits of Horsefly River, B. C. This second specimen is much more perfect than the hitherto only known specimen and type from the north fork of the Similkameen River. The other specimens from Horsefly River, found in association with the second specimen of *Amyzon brevipinne*, are referred to *A. commune* Cope, the characteristic fish of the Amyzon beds of Colorado. With the discovery of a scale from the Similkameen beds, referable to *A. commune*, a fish fauna of two species common to the Similkameen and Horsefly beds is completed. The assignment of an equal age to the Horsefly and Similkameen deposits follows, and Cope's correlation of the latter beds with the Amyzon beds of Colorado and Nevada is strengthened. The beds near Tranquille, Kamloops Lake, holding remains of *A. commune* are also regarded as belonging to the same horizon.

'Observations on and Criticisms of Microchemical Methods,' by Dr. A. B. Macallum.

'The Structure of the Mesogloea in the Medusæ, *Aurelia flavidula* and *Cyanea arctica*,' by Dr. A. B. Macallum.

'On the Structure of an Abnormal Chick Embryo,' by Professor R. Ramsay Wright.

The case discussed is an interesting one of *Duplicitas anterior*, which supplements those previously recorded. It shows no indication of a second primitive streak, but otherwise resembles most closely those described by Hoffman and Kaestner.

'A Chapter in Comparative Physiology and Psychology,' by Dr. T. Wesley Mills.

The paper treats of the habits of a hawk and a crow as observed in confinement in the laboratory, together with an account of some physiological experiments made with a view to throw light upon the

nature of the brain and the psychic organization of the bird.

'South African Iron Formations,' by Professor A. P. Coleman.

During the visit of the British Association to South Africa, rocks formed of iron ore interbanded with jasper or granular silica were studied at Johannesburg and Salisbury, while similar specimens were obtained from other parts of the subcontinent, all very like rocks of the iron formation of northern Ontario and the Lake Superior region. In South Africa these iron-bearing rocks are in general not so ancient as in America, though lower than the lowest known fossiliferous rocks. The conditions under which they were deposited in these two regions, so widely separated, seem to have been much the same; and conditions of the same kind have apparently not been repeated in later ages.

'Some Experimental Investigations into the Flow of Rocks,' by Professor Frank D. Adams.

The paper gives a brief account of some experimental work bearing upon the behavior of rocks when submitted to great pressure and under conditions similar to those which exist in the deeper parts of the earth's crust.

'Gypsum Deposits of New Brunswick, with Special Reference to their Origin,' by Professor L. W. Bailey.

The gypsum deposits of New Brunswick are among the most important to be found in Canada, and have long been the basis of large and profitable industries, the annual export from a single locality, that of Hillsboro, in Albert County, to the United States, having been, for some years, not less than 20,000 barrels of manufactured plaster, in addition to from 25,000 to 50,000 tons of crude gypsum, besides a large amount used for Canadian consumption. The very extensive operations here referred to, carried on below as well as

upon the surface, afford unusual facilities for the study of rock plaster in all its varied forms, and for the consideration of the theories which have been proposed to account for the origin of the latter. One of these theories, strongly advocated by Sir William Dawson, supposed the gypsum to result from the reaction of sulphuric acid, an indirect product of volcanic action, upon limestone; while a second supposes the same product to have resulted from direct precipitation from sea water in shallow land-locked basins, under conditions of high temperature and aridity. While the latter view, based on observations of inland salt sea, like those of Utah, is now generally accepted, much diversity of opinion still exists as to the separate origination of gypsum and anhydrite, some maintaining the former and some the latter to have been the original and antecedent rock, while still others suppose that either or both may be deposited from the same solution, according to varying conditions of temperature, depth of water, presence of saline salts, etc. It is the purpose of the present paper to consider some of these views, and especially such as relate to the occurrence and origin of gypsum and anhydrite (soft and hard plaster) in the light of observations recently made by the author in the Hillsboro quarries, with incidental references to those found elsewhere in the province.

'Features of the Continental Shelf off Nova Scotia,' by Dr. H. S. Poole.

This paper treats of the preglacial drainage when the country was much elevated, where the mouth of the ancient St. Lawrence River was one hundred miles eastward of Cape Breton, theorizes on the origin of the Strait of Canseau, and suggests that the ice sheet extended well beyond the present shore line.

'Notes on Tertiary and Cretaceous Plants,' by Professor D. P. Penhallow.

The basis of the present paper is found in several collections of plants from localities in British Columbia, placed in the author's hands by the geological survey for determination in the spring of 1905. Only the names of the identified species have so far been reported, and as it seems desirable that some of them should be dealt with more in detail, and the correlation of geological horizons indicated, they are now described at length. It is shown in connection with more recent studies that both the Tertiary and the Cretaceous forms may be definitely correlated with previously known floras, and that they are chiefly of Oligocene and Shasta-Chico age, respectively.

The author also directs attention to some recently studied material from the Pleistocene of Elmira, New York. This material consists of two specimens of the common white elm, and one specimen of a maple which can not be correlated with any existing species. It is, therefore, designated as *Acer newtownianum* in reference to the Newtown Creek, in the gravel banks of which the woods were found. Attention is directed to the occurrence of leaves of *Acer pleistocenicum* Penh., in the Pleistocene clays of the Don Valley, and the possible connection between the extinct species represented by wood, and the one now represented wholly by leaves, is pointed out.

'Review of the Flora of the Little River Group, Part I., the Calamariæ,' by Dr. G. F. Matthew.

The writer will give in this paper and later ones, the result of the revision of the plant remains, studied and described by the late Sir William J. Dawson, that were found in plant-bearing strata in and near St. John, N. B., Canada. In this examination will be embodied the revision of the types of this flora returned by Sir William to the Natural History Society of New



Brunswick, as well as the study of new material collected later by Messrs. Wilson, Stead, McIntosh, Leavitt and others. This new material, it is hoped, will give more completeness to the results.

The need of a reexamination of these plants is forced upon us not only by the changes in nomenclature that have been accepted since Sir William wrote his classic essays on this subject, but also by the fact that eminent paleobotanists have questioned the reference of these plants to the Devonian age, and have asserted that they were Carboniferous.

The writer does not propose to take up at present the stratigraphical evidence upon which is based the reference of the terrane which holds these plants to the Devonian age, but only to study the plants themselves and note the beds from which they have come; the stratigraphy may be left to a later occasion. It was in connection with the labeling of the types of Sir William's species, in the Museum of the Natural History Society of New Brunswick, that such revision was found to be necessary.

Since Sir William's work was performed new species have been found in these beds, including some novel types of the calamariæ and the ferns (as well as insects and myriapods). These will be described and figured in this series of articles and the writer hopes may prove of interest to paleobotanists.

The terrane in which the plants are found is thought to cover a considerable interval of time and not to be confined to the Middle Devonian as Sir William Dawson's determination of the flora has led many to suppose. While there is a group of species of wide range of time (*e. g.*, *Calamites Suckovii*) in these beds, there are others that are confined to special portions of the terrane and it is these species which give character to the fauna.

'On some Fossils from Northern Canada,

collected by Commander Low, during the Expedition of 1903-04, together with Notes on the Geological Horizons to which they Belong,' by Dr. H. M. Ami.

This paper contains descriptions of the species of fossil organic remains supposed to be new from Beechy Island, Cape Chidley, and from Southampton Island, collected by Commander A. P. Low, during the cruise of the steamer *Neptune* in 1903 and 1904, in the Arctic regions and other portions of northern Canada, together with notes on other forms occurring in that portion of the Dominion. The geological formations to which the fossils known to occur in that portion of Canada belong will also be discussed and an attempt made to correlate them with geological horizons elsewhere in the Dominion.

'Note sur les Bassins Hydrographiques des Rivières Montmorency et Ste. Anne,' by Abbé J. C. K. Laffamme.

A rather remarkable anomaly exists regarding the quantity of water in the valleys of the Ste. Anne and Montmorency Rivers. The two hydrographic basins appear to be about equal as regards areas drained, and, moreover, they are side by side. They both receive the same quantity of precipitation. The paper deals with the probable reasons for the differences in the amount of water each carries.

'Notes on the Mineral Fuels of Canada,' by Dr. R. W. Ells.

This paper discusses the various kinds of mineral fuels found in Canada, including the various kinds of coals, from anthracite to the newest lignite, anthraxolite, albertite bituminous shales, petroleum, natural gas, peat, etc., with their distribution in so far as at present known in all the provinces of the Dominion, mode of occurrence, extent and economic value.

'A Remarkable Outgrowth from the Trunk of a White Birch,' by Professor D. P. Penhallow.

At the time of the recent forestry convention at Ottawa, my attention was directed to a remarkable growth said to have been found in New Brunswick. Subsequently a specimen was submitted to me for examination by the Hon. T. G. Loggie, of the crown lands department, in whose museum the original specimen was deposited.

The specimen, described as being twenty feet in length, was found to consist of a flattened cord of tissue, with a perfectly normal outer bark like that of the white birch, and within it was composed of cork tissue which had resulted from the rapid transformation of living bark structure. The fact that this cord was attached to the tree by the upper end only, and that it therefore hung altogether free for its entire length, presented a problem of an unusual character with respect to the growth of trees in this latitude; but it is shown that the phenomenon may be accounted for on the supposition that an injury to the bark had given rise to an outgrowth presenting extraordinary rapidity of development, and that the growing tissue was converted into cork as fast as projected.

'Critical Notes on the Geometridæ of British Columbia, with Descriptions of Fourteen Species,' by Rev. G. W. Taylor.

Introductory observations on the present state of our knowledge of the group, and review of the work of previous writers. List of the species known to occur in British Columbia, with critical notes on the nomenclature, distribution and life history of each species. Description of forms new to science. Bibliography.

'Distribution of Bacteria in Canadian Cheddar Cheese,' by Professor F. C. Harrison, presented by Dr. Fletcher.

'Legume Bacteria,' by Professor F. C. Harrison, presented by Dr. Fletcher.

'Studies in Canadian Fungi.'

(1) 'The Imperfect Fungi,' by John Dearnness, communicated by Dr. G. U. Hay.

(2) 'The Hydnums and their Allies,' by Dr. G. U. Hay.

'Some Unsolved Problems in Immunity,' by Dr. A. G. Nicholls, presented by Professor Wesley Mills.

A short historical *résumé* of the development of our modern ideas as to the nature of immunity. The two opposing schools and their explanation of the phenomena of the healing of infectious disease. An account of the recent experimental work tending to reconcile their divergent views. Methods by which the resisting power of the animal organism may be increased. Natural and artificial immunity. An attempted rational explanation of the processes of healing.

'On the Sleeping Sickness; with Microscopic Illustrations,' by Sir James Grant.

The recent discovery during the past year of protozoal parasites in the blood of different animals, in addition to many new species of *Trypanosoma*, is of much interest, owing to the close affinity of these discoveries with sleeping sickness, the epidemic area of which is confined to parts of equatorial Africa.

#### BIBLIOGRAPHIES.

'Bibliography of Canadian Geology and Paleontology for the Year 1905,' by Dr. H. M. Ami.

'Bibliography of Canadian Zoology, Exclusive of Entomology, for the Year 1905,' by Dr. J. F. Whiteaves.

'Bibliography of Canadian Entomology for 1905,' by Rev. Dr. C. J. S. Bethune.

'Bibliography of Canadian Botany for the Year 1905,' by Dr. A. H. MacKay.

The presidential address was delivered on the evening of Tuesday, May 22, in the assembly hall of the Provincial Normal School, where all the sessions also were held. Besides giving an excellent review of the



progress and advancement made in physics, Dr. Johnson referred to the semi-jubilee celebration of the Royal Society. A public and popular evening lecture, one of the features of the society meetings, was delivered on the following evening, by Professor C. C. James, of Toronto, on the subject, 'The Downfall of the Huron Nation.' The lecture was illustrated throughout with numerous views projected on the screen.

Some interesting functions were held—notably a dinner at the Russell House, Ottawa, and a reception and garden party at the observatory, where the public and the society had an excellent opportunity of visiting the beautiful building recently erected by the Canadian government, in charge of the Dominion astronomer, Dr. W. F. King.

H. M. AMI.

OTTAWA, May 31, 1906.

*THE INTERNATIONAL METEOROLOGICAL  
CONFERENCE AT INNSBRUCK.*

ALTHOUGH several months have elapsed since this meeting, the fact that no account of it has appeared in America prompts the writer, who was the English-speaking secretary, to give a brief statement of its nature and proceedings.

The directors of the various meteorological services and observatories of the world, to the number of fifty, met last September at Innsbruck, Austria, for the purpose of discussing questions of common interest, but without authority to pledge their respective governments to any action.

The chief of the United States Weather Bureau and Professor Bigelow were unable to attend, and, in their absence, Father Algué, of Manila, and the undersigned represented the United States. Similar conferences had been held at Munich in 1891 and at Paris in 1896, but the meeting there during the exposition of

1900 was open to all meteorologists. These reunions are arranged by the International Meteorological Committee, a permanent organization, composed of seventeen persons, who are generally the heads of meteorological services in their respective countries. At the present time the president of the committee is M. Mascart, director of the Central Meteorological Bureau of France, and the secretary is Professor Hildebrandsson, director of the meteorological observatory at Upsala. The members are chosen at meetings of the directors, and although vacancies or resignations may be filled by the committee itself, the fact that the committee had been in office during nine years made it advisable to convoke this meeting of directors in order to elect a new committee. Since 1896 the permanent committee has met three times and has received the reports of four subcommittees, appointed mostly from outside its own body to further special investigations.

The conference at Innsbruck was organized by choosing Professor Hann, of Vienna, its honorary president, and Professor Pernter, also of Vienna, its president, in place of M. Mascart, who was prevented from coming to Innsbruck. Professor Hildebrandsson, of Upsala, and General Rykatchef, of St. Petersburg, were elected vice-presidents. In his opening address Professor Hann reviewed the great progress which meteorology had made since the first conference at Leipzig in 1872, chiefly through the exploration of the upper air, which, by the erection of mountain observatories, and especially through the use of kites and balloons during the last decade, has led to new and unexpected results. At the present time meteorology is facing such important problems as the connection between weather periods of long duration and solar conditions, a considera-

tion which is suggested by the decrease of the Antarctic ice and by the retreat of the glaciers in various parts of the world.

About forty questions had been submitted to the conference and most of them were considered by special committees formed of persons interested in the following subjects: first, international comparisons of normal barometers; second, a new edition of the standard cloud-atlas; third, reduction of the barometer readings and weather telegraphy; fourth, international cooperation in the study of squalls. The reports of these committees were generally accepted by the conference. Among the subjects considered directly by the conference were observations of solar and terrestrial radiation, which were recommended to be made with Angström's compensation actinometer; the causes of heavy rainfall over large areas and historical investigations relating to extraordinary meteorological phenomena; the designation of the shift of wind in cyclonic storms and the study of small dust-whirls, especially in the southern hemisphere; also the importance of homogeneous observations at certain secular stations in each country. The following matters were referred to the international committee, *viz.*, the classification of meteorological stations and the definitions of the different kinds of frost-formation; the establishment of rules governing the international and subcommittees and the convening of meetings, which rules are to be presented to the next conference for ratification. It was voted to codify all the resolutions that had been adopted by the conferences and to publish them in German, French, English and Spanish. Besides the discussions and resolutions, several scientific communications that required no action were presented. Chief among them were descriptions of the organization of the meteorological services in

Brazil and China, by Mr. Silvado and Father Froc, respectively, and of the new aeronautical institute near Moscow by General Rykatchef; preliminary results of the exploration of the high atmosphere over the tropical Atlantic, obtained by the expedition of the Prince of Monaco and Professor Hergesell and by that of M. Teisserenc de Bort and Mr. Rotch.

The conference elected the following members of the International Committee: Messrs. Chaves (Portugal), Davis (Argentina), Eliot (India), Hellmann (Germany), Hepites (Roumania), Hildebrandsson (Sweden), Lancaster (Belgium), Mascart (France), Mohn (Norway), Moore (United States), Nakamura (Japan), Palazzo (Italy), Paulsen (Denmark), Pernter (Austria), Russell (Australia), Rykatchef (Russia) and Shaw (Great Britain). Three of the subcommittees had their powers renewed by the conference, namely: the commission for terrestrial magnetism and atmospheric electricity, with General Rykatchef, of St. Petersburg, as president and Dr. A. Schmidt, of Potsdam, as secretary, whose special duty is to coordinate the magnetic and electrical observations over the globe; the commission for scientific aeronautics, under the presidency of Professor Hergesell, of Strassburg, which undertakes the study of the free air by simultaneous ascensions of balloons and kites; and the commission for solar radiation, which, under the leadership of Professor Ångström, of Upsala, promotes measurements of solar radiation and centralizes the results. In 1904 the solar commission was formed, with Sir Norman Lockyer, of London, as president, and Sir John Eliot as secretary, for the purpose of investigating the relations between meteorology and solar physics. The same officers were reelected at Innsbruck and the membership was enlarged. The establishment of ob-



servatories in the north of Siberia and in America was recommended, as well as stations on selected islands, and a form for publishing all the data was prescribed.

As the Innsbruck meeting was devoted to serious work, formal social functions were wisely omitted. The president, however, entertained his colleagues in the characteristic German manner on one evening, and between the sessions excursions were arranged to some neighboring portions of the Tyrol. Unusual sociability prevailed from the fact that almost all the members of the conference lodged in the same hotel where meals were taken together, and in this way old acquaintances were strengthened and new ones formed, the personal relations being, after all, the chief advantage to be derived from these reunions.

A. LAWRENCE ROTCH.

BLUE HILL METEOROLOGICAL OBSERVATORY,  
June 8, 1906.

#### SCIENTIFIC BOOKS.

##### THE BELGIAN ANTARCTIC EXPEDITION.

*Résultats du voyage du S. Y. 'Belgica' en 1897-1898-1899, sous le commandement de A. DE GERLACHE DE GOMERY. Rapports scientifiques. Botanique: Les Phanérogames des Terres Magellaniques.* Par E. DE WILDMAN. Anvers, 1905. 4°, 222 pp., xxiii pls. *Travaux hydrographiques et instructions nautiques.* Par G. LECOINTE. 1er fascic. Anvers, 1905. 4°, 110 pp., xxix pls. and atlas of charts.

During the short stay of the expedition in the Magellanic region M. E. Racovitska obtained rather exhaustive collections of the flowering plants of this region. The flora is not very numerous in species, but is of interest from the point of view of geographical distribution, since it establishes for some species a singularly wide distribution. A glance at the charts of the Magellanic archipelago will show the conditions leading to an intimate connection between the continental South American flora and that of the archipelago.

The posthumously published essay of the late Nicholas Alboff (1897) contained some important discussions of the relations of the Fuegian flora. In this connection Alboff observed that if it were no longer possible to base one's ideas of Antarctic plant distribution on Hooker's memorable 'Flora Antarctica' alone, without falling into error, it is also true that the considerable additions to our knowledge of that flora which have since been made (including his own) are still insufficient for the purpose. Investigations since Alboff's paper have all tended, as he expected, to connect the flora of the archipelago more and more closely with that of the continent. M. de Wildman concludes from his study of the Racovitska collections that it is still too early to attempt to discuss the general question of the geographical subdivisions into which it is probable the Fuegian flora will ultimately be subdivided. He gives tables, however, at the end of his memoir by which the reader may rapidly obtain an idea of what is known of the distribution of the species enumerated.

The memoir divides itself into a systematic enumeration of the phanerogams collected by the *Belgica*; a similar enumeration of the known phanerogamic flora of the region, and the statistical tables. The work is published in the elegant style heretofore noted in the reports of this expedition, and the plates are particularly fine and detailed.

The sheets of the hydrography by Commander Lecoite were printed as early as 1903, but owing to the pressure of duties devolving upon him as director of the Royal Observatory, the proposed plan has not been fully worked out. It was, therefore, thought best to issue the sheets as far as printed without waiting any longer. They comprise the hydrography of the voyage from Europe to Terra del Fuego and thence to Bransfield Strait; an account of the operations in Gerlache Strait; and lastly the subsequent proceedings.

One does not expect to find much of interest in the computations of chronometer rates, or observations for position, however necessary;

but in the present case the lay reader will be agreeably rewarded if his curiosity leads him to open the pages of the memoir, by the admirable and interesting series of reproductions from photographs of Antarctic scenery which appear upon the plates. The charts, as might be expected, are of the first class.

WM. H. DALL.

#### SCIENTIFIC JOURNALS AND ARTICLES.

THE June number (volume 12, number 9) of the *Bulletin of the American Mathematical Society* contains the following articles: 'Report of the April Meeting of the American Mathematical Society,' by F. N. Cole; 'Report of the April Meeting of the Chicago Section,' by H. E. Slaught; 'Groups in Which All the Operators are Contained in a Series of Subgroups such that any Two have only Identity in Common,' by G. A. Miller; 'Note on the Factors of Fermat's Numbers,' by J. C. Morehead; 'Theoretical Mechanics' (review of Whittaker's *Treatise on the Analytical Dynamics of Particles and Rigid Bodies*; with an Introduction to the Problem of Three Bodies), by E. B. Wilson; 'Some Recent Foreign Textbooks' (Course in Practical Mathematics, by F. M. Saxelby; and the following three books by Gustav Holzmüller: *Die Planimetrie für das Gymnasium*, *Methodisches Lehrbuch der Elementar-Mathematik*, *Vorbereitende Einführung in die Raumlehre*), by D. E. Smith; Notes; New Publications.

The July number (concluding volume 12) contains: 'Note on the Numerical Transcendents  $S_n$  and  $s_n = S_n - 1$ ,' by W. Woolsey Johnson; 'On Certain Properties of Wronskians and Related Matrices,' by D. R. Curtiss; 'Significance of the Term Hypercomplex Number,' by J. B. Shaw; 'How Should the College Teach Analytic Geometry?' by H. S. White; 'Four Books on the Calculus' (Schröder's *Die Anfangsgründe der Differentialrechnung und Integralrechnung*; Fricke's *Hauptsätze der Differential- und Integralrechnung*; Junker's *Repertorium und Aufgabensammlung*; Thomae's *Sammlung von Formeln und Sätzen aus dem Gebiete der elliptischen Funktionen*), by H. E. Slaught;

Shorter Notices (Stolz and Gmeiner's *Einleitung in die Funktionentheorie*; Bortolotti's *Lezioni sul Calcolo degli Infinitesimi*; Vahlen's *Abstrakte Geometrie*), by Oswald Veblen, (Cunningham's *Quadratic Partitions*), by J. C. Morehead; Errata; Notes; New Publications; Fifteenth Annual List of Papers Read before the Society and Subsequently Published; Index to Volume 12.

*Bird-Lore* for May-June contains articles on 'The Whip-Poor-Wills,' by A. D. Whedon; 'Stray Birds at Sea,' by F. M. Bennett; 'Photographing a Bluebird's Nest by Reflected Light,' by R. W. Hegner, and 'The Amount of Science in Oology,' by Thos. H. Montgomery, Jr. This article deprecates the ordinary collecting of eggs and calls attention to the small amount of really valuable work done by 'oologists'; oddly enough no mention is made of Nathusius and his studies of the microscopical structure of egg shells. There is the sixteenth paper, entirely devoted to statistic of dates of arrival, on the 'Migration of Warblers,' by W. W. Cooke.

The section devoted to the Audubon Societies gives a résumé of the various laws enacted, or that failed to pass, by various state legislatures during the past session. The 'leaflet' contains an account of the rose-breasted grosbeak.

*The Museums Journal* of Great Britain for May is largely devoted to a discussion of 'The Relation of Provincial Museums to National Institutions' and is interesting reading even if the matter does not apply to the United States. Incidentally it gives some idea of the work of the Victoria and Albert Museum. From the notes we learn of the reinstallation of the exhibition series of fishes in the British Museum, the old, dried, dingy specimens having been replaced by others colored from nature. In the United States we believe the Smithsonian Institution was the first to exhibit a series of casts of fishes, colored after nature, at the Exposition of 1876. Such casts, and fishes mounted by Denton's methods, seem to be the best methods of displaying fish at present. The British Museum has also recently placed on exhibition a group showing



the gardener bower bird of New Guinea with its natural surroundings.

*The American Naturalist* for June contains the following articles: 'Observations and Experiments on Dragon Flies in Brackish Water,' by R. O. Osburn; 'Reactions of *Tubularia crocea* (Ag.),' by A. S. Pearse, and 'The Pressure and Flow of Sap in the Maple,' by K. M. Wiegand. This reviews the various theories that have been propounded and gives a summary of the recorded facts and their probable explanations, osmotic phenomena being considered the cause of the observed pressure with the resulting flow of sap.

#### SOCIETIES AND ACADEMIES.

##### THE SOCIETY FOR EXPERIMENTAL BIOLOGY AND MEDICINE.

THE seventeenth meeting of the Society for Experimental Biology and Medicine was held in the laboratory of the Department of Health of New York on Wednesday evening, May 23. The president, Simon Flexner, was in the chair.

*Members present:* Atkinson, Auer, Dunham, Ewing, Field, Flexner, Gies, Hatcher, Lee, Levene, Mandel, J. A., Meltzer, Meyer, Norris, Opie, Park, Richards, Salant, Terry, Wadsworth, Wallace.

##### *Abstracts of Communications.*<sup>1</sup>

*Analogies between the Phosphorized Fats Obtained from the Brain and Kidney*, with exhibition of products: EDWARD K. DUNHAM.

The author has found that substances closely related to the lipoids derived from the brain may be obtained by similar methods from the kidney. In this communication the author gave chiefly his analytic data for kidney products resembling Thudichum's sphingomyelin and paramyelin.

<sup>1</sup>The abstracts presented in this account of the proceedings have been greatly condensed from abstracts given to the secretary by the authors themselves. The latter abstracts of the communications may be found in current numbers of *The Journal of the American Medical Association*, *American Medicine*, the *New York Medical Journal* and volume three of the Society's Proceedings.

*The Toxicity of Indol:* A. N. RICHARDS and JOHN HOWLAND.

A series of experiments on rats, guinea pigs and rabbits have shown that if the capacity of the cells of utilizing oxygen is diminished as by potassium cyanid, or chloroform, the intensity and duration of symptoms following the injection of definite doses of either indol or phenol are increased.

The experiments were made as a part of a study of the etiological factors in recurrent vomiting in children. At the beginning of these seizures there are signs of diminished oxidation (increased elimination of uric acid, neutral sulfur, lactic acid, aceton bodies) and an abnormally intense indican reaction. It is believed that failure to oxidize completely substances of the type of indol, results in the production of distinct mental symptoms and in the partial excretion of the substances into the gastro-intestinal tract. The disturbance induced by such substances is capable of producing nausea and vomiting.

*The Formation of Urea:* L. B. STOOKEY and A. S. GRANGER. (Presented by R. A. Hatcher.)

Subcutaneous injection of liver-extracts (dog) was found to lead, in the dog, to an increased elaboration of nitrogenous end-products into urea. Liver-extracts which had been heated to 55° C. were not found to possess this stimulative action. These results might indicate an enzymatic formation of urea. Further experiments are in progress.

*The Effects on Embryonic Development of the Roentgen Rays Acting on the Spermatozoa of the Toad Previous to Fertilization:* C. R. BARDEEN.

The results of the author's experiments may be briefly summarized as follows:

1. The spermatozoa of the common toad retain power of movement and fertilization for from one half to nearly three hours in a dish of lake-water at room temperature. On hot days they die sooner than on cool days.

2. Spermatozoa when under exposure of Roentgen rays die sooner than when not thus exposed.

3. When spermatozoa are exposed to the

rays so long that very few are capable of fertilizing ova, the eggs thus fertilized usually do not develop into larvae, but they may do so.

4. When spermatozoa have been exposed for a considerable period to the Roentgen rays and yet are still capable of fertilizing a considerable proportion of eggs placed in the same dish, the eggs seem to develop normally at first, but beyond the gastrula stage the development becomes retarded and the resulting larvae are markedly deformed. These deformities are quite varied. In one larva, for instance, a considerable part of the central nervous system and the gills were undeveloped on one side, while the abdominal viscera were developed only on that side. In another the central nervous system was abnormal on both sides and the alimentary canal quite defective. Considerable further study is necessary to determine accurately the nature of all the abnormalities present in the various monsters the author has preserved. Apparently all are defect abnormalities. From the results obtained it may also be concluded:

1. That nuclear material may be so influenced by exposure to the Roentgen rays that after a latent period it will call forth marked abnormalities in development.

2. That injury to spermatozoa capable of fertilizing ova may cause the development of monsters from the ova thus fertilized.

*A Vago-esophageal Reflex:* S. J. MELTZER and JOHN AUER.

The general knowledge of the contractions of the esophagus is confined to the peristaltic movements, that is, the consecutive contractions of the successive parts of the esophagus following a normal deglutition, or, as it was described by Meltzer at a previous meeting of this society, after an injection of liquid or insufflation of air directly into the esophagus. A simultaneous contraction of the entire esophagus can be produced only by stimulating the peripheral end of the vagus when cut in the neck.

The authors discovered that in dogs a tetanic contraction of the entire esophagus can be caused also by reflex ways. When the vagus is cut in any part of the neck, an elec-

tric stimulation of its central end causes a prompt longitudinal and circular contraction of the entire esophagus, which lasts as long as the stimulation continues. Particulars and other interesting facts connected with this observation will be reported later.

*Ion Protein Compounds, with Exhibition of Products:* WILLIAM J. GIES.

The author drew attention to the desirability of studies of definite compounds of proteins, and described a method of preparing dissociable inorganic salts of glucoproteins and nucleoproteins. Numerous lines of investigation that have been opened by this observation were discussed and are in progress.

*Some Facts Showing that the Brain Educts Termed Phrenosin (1874) and Cerebron (1900) were Practically the Same:* WILLIAM J. GIES.

A careful study of the chemical facts regarding phrenosin and cerebron has convinced the writer that these two brain educts were essentially the same. The name cerebron appears to be superfluous, although the preparation called cerebron has been studied more thoroughly than the other.

*A Simple Electrical Annunciator for Use in Metabolism Experiments, and in Connection with Filtration, Distillation and Similar Operations, with Demonstration:* WILLIAM H. WELKER. (Communicated by William J. Gies.)

The annunciator shown to the society consists of two square boards ( $4\frac{1}{2} \times 4\frac{1}{2} \times \frac{3}{8}$  inch) securely fastened together with a piano hinge on one side, and kept apart by a spring perpendicularly arranged at the opposite side in such a way as to permit a definite pressure to force the surfaces of the boards together. The spring can be adjusted so as to increase or decrease, within considerable limits of weight, the amount of force (weight) required to bring the boards in contact. In the opposed surfaces of the boards platinum electrodes (plate and points) are so placed that perfect contact between them is effected when the boards are brought together and the circuit is closed. The electrodes connect with binding posts on the hinged side. A small dry cell is



used. The entire apparatus, including bell attachment, may be placed on a surface 5 x 8½ inches. The bell employed directly with the apparatus is a small one with delicate musical sound. Its ringing does not disturb the animal. It is obvious, of course, that the apparatus may be connected with a bell in a room some distance from that in which the animal is kept.

In the demonstration it was shown that the apparatus announced the deposit in an ordinary urinary receiver placed on it of volumes of water less than 5 c.c. The apparatus may be adjusted to announce delivery of a volume as small as 1 c.c. and may be made, in larger sizes, to announce the deposit of masses of any desired weight.

The annunciator was made especially for use with Gies's metabolism cage, in connection with its urine receiver.

*Some Observations on the Presence of Albumin in Bile:* WILLIAM SALANT.

The author's results thus far, although not uniform, make it seem probable that the albuminuria that results from poisoning with ethyl or amyl alcohol, as observed in animals with permanent fistulas, might have been due to irritation of the bladder and perhaps only slightly to lesions in the liver. The question whether albumin passes more readily into the bile than it does into the urine was also studied. The results in every instance examined showed considerable quantities of albumin in the urine after poisoning with amyl alcohol.

More decided effects were obtained with ricin, which seemed to cause the appearance of considerable albumin in the bile.

WILLIAM J. GIES,  
*Secretary.*

THE UNIVERSITY OF COLORADO SCIENTIFIC SOCIETY.

DURING the months of April and May the society held seven meetings, at which papers were presented as follows:

PROFESSOR E. C. HILLS: 'Esperanto, the new Universal Language.'

DR. F. R. SPENCER: 'The Prevalence of Near-sight and the Reasons for its Development.'

PROFESSOR CHARLES B. DYKE: 'Hawaii and its People.'

PROFESSOR JOHN B. PHILLIPS: 'The Divorce Problem.'

DR. H. B. LEONARD: 'Practical Results of Higher Mathematics.'

DR. O. M. GILBERT: 'Death due to Embryonic Structures.'

MR. G. S. DODDS: 'The So-called Artificial Creation of Life.'

Officers for the coming year were elected as follows:

*President*—Professor William Duane.

*Vice-president*—Dr. O. M. Gilbert.

*Secretary*—Mr. G. S. Dodds.

*Treasurer*—Professor John A. Hunter.

FRANCIS RAMALEY,  
*Secretary.*

BOULDER, COLO.,  
June 1, 1906.

DISCUSSION AND CORRESPONDENCE.

COLLEGE ENTRANCE EXAMINATIONS.

TO THE EDITOR OF SCIENCE: Professor Thorndike's article on 'College Entrance Examinations' in SCIENCE for June 1 seems to me so timely and so important that teachers who agree with the general substance of it may well say so. An experience of something like twenty-five years, mostly in secondary schools, has led me to take the same view of the matter which Professor Thorndike has so thoroughly set forth. It would be worth while to get the principal of some large fitting school to give in considerable detail his experiences in regard to the inadequacy of the entrance examination to test the boy's fitness for college. I will not in this place undertake to give detailed evidence, but only to cite a few instances which occur to me at once in regard to the imperfectness with which examinations test the attainments of the student. I have known of a class in science in a very highly respected private preparatory school securing the signature of the instructor to the laboratory note-books before his departure for Europe some weeks before the end of the school year. After the signature was affixed, the ablest boy in the class completed by himself a large portion of the whole year's

laboratory work. The remaining pupils copied his notes and the whole class passed into college triumphantly as regards the subject in question on the high quality of these note-books. I have known somewhat similar instances in the same subject in one of the most celebrated public fitting schools in the United States. I have known of a young man getting a mark of 30 per cent. on his entrance examination paper in advanced Latin which he copied in the examination room and which was pronounced by two experienced Latin teachers to whom he submitted his duplicate copy to be an admirable paper, worth 80 per cent. or more. The same student in the same entrance examinations, failed in his elementary geometry and was credited as having passed in a year's advanced mathematics and a year's advanced Greek, neither of which subjects had he ever studied, and in neither of which was any paper presented. He also received a higher mark in advanced French than in elementary French.

This, of course, was pure blundering on the part of the college office, but such blunders are neither unprecedented nor uncommon.

As regards examinations in college, I have known a boy to pass his examination on a half-year laboratory course in botany on twelve private lessons without laboratory work, the boy having been rusticated during the time when the course was carried on. In another instance, in a course in the history of Greek art, a student, whom we will call X, had attended less than 5 per cent. of the lectures and had read no text-book, did not even know what the text-books were. After about twenty hours' tutoring from a student friend, the two young men took the examination and X received a mark of 85 per cent. His friend Y, who had tutored him, received a mark of 55 per cent. The instructor, on being questioned by the two students as to how their marks could have been as reported, professed himself perfectly unable to understand the situation, but it appeared that the inferior penmanship and rather prolix paper of Y had caused his paper to receive very scanty consideration. At the mid-year examination Y

received a mark of 30 per cent., mainly because his paper contained a summary of all the important facts that had been presented by the instructor, and was, therefore, intolerably long.

The reasons why examinations fail to rate students properly may be briefly summed up as follows:

1. It is extremely difficult for any one but the person who has taught a class to set a paper which shall fairly test the work done by the class. Every teacher can recall many instances where his examinations have failed to call out the knowledge which he knew the class to possess.

2. There is, as Professor Thorndike suggests, an enormous factor of unknown value to be attributed to the influence of coaching.

3. There is a broad field for the perpetration of blunders which vitiate the whole record of the results of the examinations.

4. There is the constant allowance to be made for actual dishonesty on the part of the students examined, for it is a well-known fact that examinations are regarded by the average boy, and by the occasional girl, as game which may be stalked and shot down by the aid of any amount of trickery. Not infrequently epidemics of cheating run through a large school, and I well remember one which infected a very important institution during the entire school life of one set of pupils.

The remedy for the evils due to unchecked grading by examinations, in school or college, must consist in a partial return to the old-fashioned system of recording in some fashion the instructor's impressions of the daily work, in making examinations briefer and more frequent, and giving them at wholly unexpected times. College entrance examinations should at any rate be balanced by the school's report of the pupil's standing in his several subjects, and the schools should be held to so strict an account for their recommendations that such a set of certified note-books as that above described should be absolutely impossible.

J. Y. BERGEN.

CAMBRIDGE, MASS.,  
June 8, 1906.



## SERMONS IN STOMACH STONES.

MOLIÈRE presents to us in one of his comedies the father of a dumb girl who wants to know why his daughter is dumb. 'Nothing is more easy to explain,' says the pretended physician Sganarelle; 'it comes from her having lost the power of speech.' 'Yes, yes,' objects the father, 'but the cause, if you please, why she has lost the power of speech?' Sganarelle is at no loss for an answer: 'All our best authors will tell you that it is the impeding action of the tongue.'

Somewhat similarly, if one asks the definition of a 'stomach stone,' one is told that it is a 'gastrolith';<sup>1</sup> and our best authors declare sapiently that gastroliths are pebbles that have been swallowed by fossil reptiles of '*lithophagous proclivities*.'<sup>2</sup> Predilection for this hard fare is accounted for by ascribing to the reptiles in question a bird-like gizzard; and the upshot of the matter is that we find evidence 'of additional important structural analogies with the birds,' *quod erat invenendum*. Much the same method of reasoning led the jovial Tom Hood, in his 'Geological Excursion to Tilgate Forest, A.D. 2000,' to affirm that *Mylodon* subsisted upon a diet of 'raw potatoes and undressed salads.'

We have no wish to impugn the worth of stomach stones, nor of related bodies known as uroliths and coprolites, as a fit subject for scientific inquiry, and as a means of satisfying hunger and thirst after knowledge. All are capable of large returns, as witness, for example, the fecund results of M. Bertrand, whose memoir<sup>3</sup> of 150 odd pages, illustrated by fifteen plates, is at once edifying, delectable and *digne*; that is, fully commensurate with the materials. The argumentation employed is informed with severest logic, in which undisciplined imagination has no place; and the author seeks to test, verify, or at least fortify, his conclusions as far as possible by the experimental method. An evident longing to get at the bottom of things is shown in

<sup>1</sup> SCIENCE, Vol. XXIII., p. 820.

<sup>2</sup> *Ibid.*, Vol. XX., p. 565.

<sup>3</sup> 'Les coprolithes de Bernissart.' Mém. Musée Roy. d'Hist. Nat. Belg., T. I., 1903.

the sections entitled by him 'Etude de la pâte fécale,' and 'Résumé de quelques expériences sur la destruction de divers types de crottins,' the latter including a notable category. Our foreign colleague is conspicuous for his firm grasp of the subject-matter, and his ornate handling of it sets an example which might well be emulated by his brethren on this side of the water. But then, as Seneca observes, speaking with all due respect: '*Gallum in suo sterquilinio plurimum posse.*'

C. R. EASTMAN.

## SPECIAL ARTICLES.

## THE FUTURE OF THE CRAYFISH INDUSTRY.

CRAYFISH in the United States form so small a part of the food supply that we are apt to rank them with mussels and snails as eaten in Europe only. But while France so highly appreciates them as to carry on the business of rearing them to increase the natural supply coming from her own waters and those of neighboring countries; there is actually a growing consumption of crayfish as food in the United States. In New York, New Orleans, San Francisco, Chicago and other cities crayfish are sold both as food and as garnish, as bait and as material for school and college courses in zoology.

While the actual status of the crayfish industry is difficult to determine, the following facts show that if a complete census were taken it would show the existence of a much larger use of crayfish than is at all suspected. One small region, the Potomac from Washington to Fort Washington, was recently estimated by one of the most intelligent fishermen on the Maryland side to send annually to New York a half million of crayfish, while the U. S. Fish Commission publications in 1884 asserted that Montreal and Milwaukee also shipped crayfish to New York. More recent reports of the commission state that in 1902 the crayfish catch in New Orleans County, Louisiana, was 16,000 pounds, of a value of \$615, and of Monroe County, Florida, 55,664 pounds, of a value of \$3,282.

All the above crayfish and many more caught for the markets of Chicago and other

central cities belong to the American genus *Cambarus*, which occurs in the United States and Canada only. The Potomac supplies *C. affinis*; Chicago, *C. virilis*; New Orleans, *C. Blandingii*; and Montreal, *C. Bartoni*. Of late, however, a considerable fishery has developed in the Pacific states where the crayfish are all of the genus *Astacus* and more like the crayfish of England, France and Europe in general. From the statistics of the Bureau of Fisheries we learn that in Oregon 116,400 pounds of crayfish, worth \$7,760, were caught in 1899. The detailed tables, however, assign 63,000 pounds, worth \$420, to Clackamas County, where they are taken in the tributaries of the Willamette River along a stretch of only a few miles; 5,400 pounds, worth \$360, to Columbia County; 15,000 pounds, worth \$1,000, to Multnomah County; 15,000 pounds, worth \$1,000, to Washington County; and 18,000 pounds, worth \$1,200, to Yamhill County. This would make a total of 165,000 pounds in place of 116,400 pounds.

The center of the wholesale crayfish business was Portland, in Multnomah County, where the sales were 39,232 dozen crayfish, weighing 117,696 pounds and worth \$19,556.<sup>1</sup>

The catch is made in the sloughs of the Columbia and its tributary streams between March and September. A large part of the catch is used at Portland, with a considerable demand from Seattle, Tacoma, San Francisco and as far east as Salt Lake City and St. Louis. The average weight is three pounds to the dozen. As prepared for shipment the crayfish is placed alive in a composition of white wine and spices and boiled for about ten minutes. The crayfish and liquor in which it has been boiled are next packed in tin buckets holding from two to three dozen each.

Despite the incompleteness of the above data it is evident that considerable numbers of crayfish are sold and that they find a market even in Pacific, Atlantic and Gulf states, where they compete with salt-water crustacea; in San Francisco with the spiny-lobster and crab, in New Orleans with the shrimp and in New York with the lobster.

<sup>1</sup> 'Notes on Fisheries of the Pacific Coast in 1899,' p. 545.

The future of this crayfish industry will obviously depend upon both demand and supply. The demand should increase; with the growth of cosmopolitan populations that appreciate such food as is used in Europe; with the growth of large populations too remote from sea coast to obtain fresh sea food; and with the increasing inadequacy of the marine crustacea to supply the needs of even those consumers who dwell near the coast. Thus the lobster industry has been strained till the use of young specimens as food to take the place of the exterminated large ones has become very extensive. At present some millions of 'short-lobsters,' six to ten inches long, are sold to summer visitors to the New England coast and many more millions are used as bait.

No doubt, in time, the demand for crayfish will exceed the natural supply and this industry will tend to run the same retrograde course as that of the lobster, oyster, clam and many more important fisheries till the real, or assumed, value of the crayfish as food, warrants legislative control and scientific aid such as alone makes possible the continuance of more and more of our once 'inexhaustible' food supplies.

Soon or later the supply of crayfish will need to be made greater. In addition to legislative restrictions and controls three lines of work suggest themselves as suitable for trial when the supply becomes deficient or, if one is to profit by experience in other fisheries, now, before the supply is deficient. First the artificial breeding of native species in the market region; second, the introduction and propagation of better species than those naturally occurring; and thirdly, the improvement in size and flavor by culture and cross-breeding.

Crayfish amongst crustacea, like carp amongst fish, lend themselves readily to pond culture and breeding. Experiments carried on here in the laboratory have demonstrated the ease with which the young of *C. affinis* can be reared and have shown two facts of economic value, namely, that the young reared from eggs laid in the spring may become sexually



mature and lay eggs the following spring when not quite one year old, and also that a female may lay eggs in two successive years. As each lays from two hundred to six hundred eggs, a few breeding females would furnish a large stock of young. These young respond readily to feeding and the resulting size seems as much dependent upon the food as upon the age of the individual. Large individuals and large races might be expected from proper culture.

Though the eggs are best cared for by the mother, it was found possible to hatch them in McDonald fish-hatching jars and thus rear them under artificial conditions from a very early stage.

As each male is capable of fertilizing several females and, moreover, as it was found that in *Cambarus* the sperm may be kept all winter in the receptacle of the female and used by her to fertilize the eggs in the spring, few males are needed for breeding and these could be used as food in the winter before the spring, when so many of them die.

This kind of crayfish grew in the laboratory to a length of four inches in three and a quarter years and was of marketable size, three inches, at the end of the second summer from the egg. Probably in the open it attains its maximum size in four or five years.

A second method of improving the supply of crayfish, the introduction of other species, seems a promising field for experiment, for it has been found here that the eggs of the large Oregon crayfish, *Astacus*, may be hatched in the laboratory and reared as readily as in the case of *C. affinis*, the native species. These young Oregon crayfish grew here under such artificial conditions to a length of 60 mm. in five months from eggs hatched in the spring. This large species has been sold for twice the price of the eastern or the southern crayfishes, and besides its larger size and weight it has the advantage of more attractive and lobster-like appearance, so that its introduction into the east should be most acceptable. In fact, large specimens brought here and kept alive in the laboratory were as long as the six-inch 'short-lobster' now used as food, and if these

crayfish were available in quantity they might be used as a substitute for such young lobsters and thus protect the lobster industry.

As the scientific study of the geographical distribution of crayfish leads to the conclusion that the Oregon crayfish, *Astacus*, is absent from the whole eastern and central states because its ancestors never got there and not because of any natural obstacle to its living there when once introduced, it would seem well worth the while for the Bureau of Fisheries, and for private individuals, to introduce large numbers of young and adult *Astacus* into waters near markets not now supplied with this superior article of food. Should it be found that this large *Astacus* may be acclimated in the east to compete with *Cambarus*, say in the Potomac, or better to take the vacant places not now occupied by any crayfish at all (such as the Connecticut River) the catching of such introduced forms would be a lucrative business that would add an acceptable article to the food drawn from fresh waters. Even the artificial rearing of these larger crayfish in central and eastern waters awaits but the developments of time to be a profitable side of fresh-water farming.

A third means of increasing the available food supply—the origination of larger races of crayfish—may remain for a later stage of the industry, but as we have more than sixty species of *Cambarus* besides several species of *Astacus* in this country and nine or more other genera in other countries, the chances would seem good for some future production of new forms from crossing and selection.

In France as far back as 1865 a successful crayfish farm supplied Leon Soubeiran with the data for making out the life history of *Astacus*, and as we have found the habits of *Cambarus* here so similar there seems no obstacle to the establishment of crayfish farms in the United States except the lack of a sufficient demand for crayfish as food.

The needs of both *Astacus* and *Cambarus* have been shown in this laboratory to be simply air, a small amount of fresh water and organic food which may be a variety of refuse animal and vegetable matter. The artificial

culture of crayfish will be profitable as soon as the market price is greater than the small cost of food, the inexpensive farm and the value of the little labor involved. The introduction of the large Oregon crayfish with its attractive colors and large claws might conceivably so stimulate the general demand as soon to raise the market value to such a profitable level.

E. A. ANDREWS.

BALTIMORE, May, 1906.

*TWO LETTERS OF DR. DARWIN: THE EARLY DATE OF HIS EVOLUTIONAL WRITINGS.*

SEVERAL letters of Erasmus Darwin have lately come into my possession, and two of them seem worthy of publication, if only for the reason that reference to his evolutionary ideas seldom occur in his correspondence. In this regard, for example, Charles Darwin states in his introduction to Dr. Krause's 'Erasmus Darwin,' that 'most of the letters [of his grandfather] which he possessed or had seen, are uninteresting and not worth publication.'

The earlier letter, I may note, has the merit of referring to Dr. Darwin's work on the anatomy of plants, and to his ingenious effort to show closer correspondence between the organs of the higher plants and the higher animals. Indeed, as we know from other sources, he even expected ultimately to find in plants the homologues of the animal nerves, ganglia and sense organs. Accordingly, we are not surprised to find that he refers here, in quite a matter of fact way, to the 'blood' and the 'two systems' of a plant. And he gives us also a glimpse of laboratory methods, and of his interest in getting in prompt touch with the results of foreign workers.

The first of these letters is addressed to 'Sir Joseph Banks, Bart. Soho Square London.' and is as follows:

RADBURN MAR. 16—82

Dear Sir,

I return'd your sixth volum of the Ameenit. academ. & thank you for the loan of it. I should have sooner sent it, but hoped to have received another copy of Murray, & also that Dr. Linneus's supplementum would have been procured from

abroad, & thence meant to have returned them together.

Mrs. Blackburn favor'd us with a copy of Murray, but desired it to be returned in three months, which it was to a day; & as I could procure but one other, & our society was not all resident at Lichfield, we were distressed on this account, but are still flatter'd with daily hopes of more copies being imported. I am sorry you say the remainder of the supplementum is not likely soon to be had.

On looking over Malpighi, & Grew, & Hales, the physiology of plants appear'd to me, not to have hitherto been under the attention of any one perfectly acquainted with the animal economy. Last summer I contrived to inject the absorbent system of the *Picris* with a colour'd liquor; & as the blood of that plant is white, these two systems were beautifully apparent to the eye. On reading a manuscript translation of Mr. ——— a Sweedish naturalist, I found the authors, I mentioned to you in my last, had made a set of similar experiments; & I had designed to have investigated this subject, so little understood at present, farther during the summer.

This however I have now laid aside, for perhaps more important, tho' less ingenious occupations; & shall therefore decline giving you the trouble of sending me the books you are so kind as to offer, both in your last, & in a former letter of yours, I am S<sup>r</sup>.

with great respect

your obed<sup>t</sup>. servt<sup>t</sup>.

E. DARWIN.

The second letter is of livelier interest. He denies having 'stolen' his 'Botanic Garden,' or of even having heard of its prototype, probably the 'Universal Beauty' of Brooke (1735). And he modestly predicts of the effect of his evolutionary 'conjectures.' Finally, he refers to the 'Zoonomia,' as having been on his work table—or rather 'lain by him' for 'nearly twenty years'—i. e., since about 1771. That the work here referred to is the 'Zoonomia,' there can be no doubt; he obviously means an extended evolutionary work, and, in a letter to a son, dated the following year (cited in the introduction to 'Erasmus Darwin,' above referred to, page 102), he says, that "he is studying his 'Zoonomia.'" It is, of course, well known that this work was long intended for posthumous publication. But the exact



time when the first draft of this pioneer evolutionary treatise was completed is not known. Charles Darwin says, in the Introduction, that it was intended for posthumous publication as early as 1775; and, according to the remark in the present letter, it may have been fairly complete several years earlier. There is no evidence, however, that it antedated the evolutionary writings of Buffon (1765).

This second of these letters is addressed to 'Dr. Percival Physician Manchester,' and reads as follows:

*Dear Sir,*

I am much obliged to you for the kindness of your letter; & thank you for your inquiry into the merits of a poem, from which the Botanic Garden was supposed to have been stolen; an accusation which however I had not heard of, & am the more indebted to you for shewing the falsity of it.

The first part, which you are so obliging as to inquire after, is nearly printed; & I suppose will be out, if not delay'd by the engraver, in 3 or 4 weeks. It is longer than the other, & if you are at the trouble to read it, I shall be glad of any remarks, which may improve a second edition of it; if such should be called for.

I hope you will be amused, tho' not convinced, by the conjectures in the notes on coal ("upon geology," stricken out), on the winds of this climate, & on the use of the honey to the vegetable economy.

Was I sure of such candid readers, as yourself, I should be tempted to print another work, which has lain by me nearly 20 years. Adieu.

I am, dear Sir,

Your much obliged

& obed<sup>t</sup>. serv<sup>t</sup>.

E. DARWIN.

Derby

Jun. 18—91.

BASHFORD DEAN.

COLUMBIA UNIVERSITY.

#### STATISTICS OF MORTALITY.

THE Bureau of the Census has published a report presenting mortality statistics for the United States for the five calendar years 1900 to 1904. This report was prepared under the supervision of the late William A. King, chief statistician for vital statistics.

The number of deaths reported in the registration area in 1900 was 539,939, and the death

rate per 1,000 of population was 17.6. In 1901 the rate declined to 16.6 and in 1902 to 16. The rate increased in 1903 to 16.2 and in 1904 to 16.7. The average annual rate for the five years was 16.6 per 1,000. The corresponding rates in certain foreign countries are shown in the following table:

COUNTRY.	NUMBER OF DEATHS PER 1,000 OF POPULATION: 1900 TO 1903.				
	Annual Average.	1900	1901	1902	1903
Registration area of					
United States.....	16.6	17.6	16.6	16.0	16.2
England and Wales.....	16.7	18.2	16.9	16.2	15.4
Scotland.....	17.5	18.5	17.9	17.2	16.6
Ireland.....	18.1	19.6	17.8	17.5	17.5
Germany.....	20.7	22.1	20.7	19.4	( <sup>1</sup> )
Prussia.....	20.3	21.8	20.5	19.2	19.8
Norway.....	14.9	15.9	14.9	13.9	14.8
Sweden.....	15.8	16.8	16.1	15.4	15.1
Hungary.....	26.3	26.9	25.4	27.0	26.1
Netherlands.....	16.7	17.8	17.2	16.3	15.6
Belgium.....	17.6	19.3	17.2	17.3	17.0
Switzerland.....	18.0	19.3	18.0	17.2	17.6
Spain.....	26.9	28.9	27.7	26.1	25.0
Italy.....	22.5	23.8	22.0	22.1	22.2

The average annual death rate in the registration states was 17.8 per 1,000 in the cities of 8,000 or more population in 1900 and 14.3 per 1,000 in rural districts, which, as the term is here used, includes everything outside these cities. The average annual rates were lowest in St. Joseph, Mo. (7.6); Owosso, Mich. (10.1); Lincoln, Nebr. (10.4); and St. Paul, Minn. (10.5); and highest in Charleston, S. C. (31.3); Wilmington, N. C. (28.2); and Jacksonville, Fla. (28.1).

#### THE SEVENTH INTERNATIONAL ZOOLOGICAL CONGRESS.

THE sixth International Zoological Congress, which met at Berne in 1904, accepted the invitation of the American Society of Zoologists to hold the seventh congress in America in August or September, 1907, under the presidency of Mr. Alexander Agassiz.

The arrangements for the seventh congress are in charge of a committee of the American Society of Zoologists, consisting of Messrs. Alexander Agassiz, chairman; Samuel Hen-

shaw, secretary; W. K. Brooks, H. C. Bumpus, E. G. Conklin, C. B. Davenport, C. H. Eigenmann, L. O. Howard, D. S. Jordan, J. S. Kingsley, F. R. Lillie, E. L. Mark, C. S. Minot, T. H. Morgan, H. F. Osborn, G. H. Parker, R. Rathbun, J. Reighard, W. E. Ritter, W. T. Sedgwick, C. W. Stiles, A. E. Verrill, C. O. Whitman, E. B. Wilson and R. R. Wright.

The meetings will open in Boston, where the scientific sessions will be held, and from which excursions will be made to Harvard University and to other points of interest. At the close of the Boston meeting the congress will proceed to Woods Hole, Massachusetts, visiting the Station of the United States Bureau of Fisheries, the Marine Biological Laboratory and the collecting grounds of the adjacent seacoast. The journey to New York will be by sea through Long Island Sound. In New York the congress will be entertained by Columbia University, the American Museum of Natural History and the New York Zoological Society, and excursions will be made to Yale University, to Princeton University and to the Carnegie Station for Experimental Evolution. From New York the members will proceed to Philadelphia and Washington. Tours will be planned to Niagara Falls, to the Great Lakes, Chicago and to the West. It is hoped that arrangements can be made for reduced transportation for members of the congress on transatlantic lines and on the American routes.

The first formal circular announcing the preliminary program of the congress will be issued in October, 1906. All inquiries should be addressed to G. H. Parker, Seventh International Zoological Congress, Cambridge, Massachusetts, U. S. A.

#### *MINUTE OF THE FACULTY OF MEDICINE OF HARVARD UNIVERSITY ON THE RETIREMENT OF PROFESSOR BOWDITCH.*

IN parting with their colleague, Henry Pickering Bowditch, the members of the faculty of medicine of Harvard University wish formally to express to him their feelings of affection and respect.

They desire to record their recognition of the great value of his researches in physiology, the wide range and originality of his work, his public service as a courageous defender of the freedom of research, and the inspiration given to his pupils now teachers in other schools in this country.

They feel under especial obligation to him for his leadership in their councils, for his efficient aid in the reform of medical education, and for that good judgment and foresight which through many years have aided them in developing a school of medicine of a character deserving the position it holds in the science and civilization of their day.

It is a source of gratification that his life's work has been recognized by many great centers of learning; but by no body of men has it been more thoroughly appreciated than by his comrades of the medical faculty.

#### *SCIENTIFIC NOTES AND NEWS.*

THE American Association for the Advancement of Science opens its special summer meeting at Ithaca on June 29, under the presidency of Professor William H. Welch, of the Johns Hopkins University. Excellent programs are promised by the sections devoted to physics, chemistry, mechanical science and engineering, zoology and social and economic science. The sections devoted to geology and geography, and to botany will be concerned especially with field work. Reports of the meetings of the association and of the affiliated societies will be reported in subsequent numbers of *SCIENCE*.

THE announcement has been made of the resignation of Dr. William T. Harris, commissioner of education, and of the nomination of his successor, Professor Elmer E. Brown, of the University of California. Dr. Harris's retirement has been made possible by a retiring allowance from the Carnegie Foundation for the Advancement of Teaching. This action was taken by the trustees of the foundation under one of their rules which permits of such action in the case of extraordinary and unusual service to education. Dr. Harris has been the commissioner of education since



1889 and has, perhaps, had a larger and more intimate connection with the whole body of teachers than any other man. The offer to him of this retiring allowance was an act of the highest regard for his work and places his name at the head of the list of distinguished men who have accepted such retiring allowances from the Carnegie Foundation.

DR. W. W. BAILEY, professor of botany at Brown University, has retired from active service. His colleagues have presented to him a loving cup bearing the following inscription: "Presented to William Whitman Bailey, A.M., LL.D., professor of botany, by his associates in the faculty, in loving recognition of twenty-nine years of honorable service in Brown University, June, 1906."

DR. D. T. MACDOUGAL, director of the department of botanical research of the Carnegie Institution of Washington, has been elected a foreign member of the Hollandsche Maatschappij van Wetenschappen.

PRINCETON UNIVERSITY has conferred its doctorate of science on Mr. A. E. Shipley, F.R.S., lecturer in zoology at the University of Cambridge.

DR. ALEXIS Carrel, of the University of Chicago, has accepted a position in the Rockefeller Institute for Medical Research, New York, and Dr. C. C. Guthrie, also of the physiological department of the University of Chicago, has accepted a call to St. Louis University.

MR. HOWARD S. REED has resigned his position as instructor in botany in the University of Missouri and has taken an appointment in the Bureau of Soils of the U. S. Department of Agriculture. He will be engaged in studying problems in plant physiology in connection with the fertility investigations of the Bureau of Soils.

MR. HAROLD A. WHITTAKER, A.B. (Wisconsin), has been appointed assistant bacteriologist for the state of Ohio.

PROFESSOR J. G. MCKENDRICK has resigned the chair of physiology at Glasgow, which he has held for thirty years.

DR. KARL VON DEN STEINEN has retired from an associate professorship of ethnology in the University of Berlin and the curatorship of the museum of ethnology in order to devote himself to scientific exploration.

MR. HALDANE, M.P., British secretary of state for war, opened the electrical laboratory of the National Physical Laboratory on June 25.

MAJOR LEONARD DARWIN will lecture next winter at Harvard University on 'Municipal Ownership and Public Service Industries.'

THE course of Lane medical lectures of the Cooper Medical College of San Francisco, beginning on August 20, 1906, will be given by John C. McVail, M.D., of Glasgow, Scotland. The subjects of the lectures will be 'Practical Hygiene, Epidemics and Preventive Medicine.'

DR. W. H. MANWARING, of Indiana University, has been invited to give a paper before the British Medical Association at its meeting in Toronto in August.

PROFESSOR K. BIRKELAND, of Christiania, will read a paper before the Faraday Society, London, this month, entitled 'Oxidation of Atmospheric Nitrogen by Means of the Electric Arc.'

WE learn from *Nature* that Dr. Bernhard Mohr, of London, recently presented to the museum of the German Chemical Society 100 letters written by the famous Liebig to Dr. Mohr's father, the late Professor Friedrich Mohr, of Bonn, during the years 1834 to 1869.

DR. HARRISON EDWIN WEBSTER, formerly professor of natural history at Union College, professor of geology and natural history at the University of Rochester and president of Union College, died on June 16, at the age of sixty-five years.

GEORGE J. SNELLUS, F.R.S., a British metallurgist, known for his improvements in the manufacture of steel, died on June 20, at the age of sixty-nine years.

DR. RUDOLF KNIETSCH, the director of the Badische Anilin- und Soda-Fabrik, who rendered important service in developing the preparation of synthetic indigo, died on May 28 at the age of fifty-two years.

PROFESSOR DANIEL GEORG LINDHAGEN, the Swedish astronomer, died on May 5, at the age of eighty-seven years.

DR. THEODOR POLLECK, formerly professor of pharmacology at Breslau, died on June 1 at the age of eighty-four years.

DR. F. HEGELMAIER, honorary professor of botany at Tübingen, has died at the age of seventy-two years.

THE death is announced of M. Bischoffsheim, founder of the observatory near Nice.

THE German Botanical Society offers a prize of 1,000 Marks for a monograph on 'Polymorphism in the Algae.'

AT the meeting of the council of the Royal Astronomical Society, held on June 1, the following resolution was unanimously agreed to: "That the council learn with deep concern of the danger threatened to the Royal Observatory, Greenwich, from the erection of a large electric generating station near the observatory and desire to represent to the admiralty at the earliest opportunity their conviction of the paramount importance of maintaining the integrity and efficiency of Greenwich Observatory, which has been adopted as the reference point for the whole world."

THE spring series of *ballons-sondes* ascensions at St. Louis, conducted by Mr. Rotch, director of the Blue Hill Observatory, proved very successful, since twenty of the twenty-one instruments despatched have been recovered, most of them with good records of barometric pressure and temperature. The experiments were in charge of Mr. S. P. Fergusson, mechanic of the observatory, and were witnessed by Professor O. L. Fassig, who will undertake similar investigations for the United States Weather Bureau.

AT the instance of the late Professor I. C. Russell, of Michigan, the Geological Society of America recently invited the cooperation of the government surveys of the United States, Canada and Mexico in the preparation of a geologic map of North America. The immediate object was to make such a map available at the approaching international geological congress in the City of Mexico.

The map is being prepared in the office of the United States Geological Survey under the direction of Mr. Bailey Willis, and will be published in connection with a professional paper. The map will be about six feet by four and a half feet in size, and may be used as a wall map or as a pocket reference.

THERE has just been published, by act of congress, a report on the geology of the Owl Creek Mountains in central Wyoming, which contains a description of a but little-known portion of the Rocky Mountain region. It is the result of an exploration made during the past summer, by N. H. Darton, of the U. S. Geological Survey, partly for the purpose of ascertaining the mineral resources of the portion of the Shoshone Indian Reservation to be opened to settlement on August 15 this year. The report is Senate Document No. 219, 59th Congress, First Session, and may be obtained by application to senators and representatives; the Geological Survey will not have the report for distribution.

PROFESSOR H. H. TURNER, of Oxford University, addressed a letter on June 2 to the editor of the London *Times*, in which he says: "The board of visitors of the Royal Observatory at Greenwich found themselves confronted, at their annual meeting yesterday, by a grave anxiety. The London County Council have established in the Greenwich meridian and within half a mile of the observatory a large station for generating electricity. There are already two chimneys, 250 feet high, which rise from the river bed above the domes of the observatory, in spite of the 150 feet of hill on which the latter is placed; as well as two other chimneys somewhat smaller. The disturbance caused by the hot air and smoke from all these chimneys can not fail to be serious, though it is at present impossible to estimate it quantitatively. But there is another source of disturbance of an alarming kind of which direct evidence has already been obtained. In spite of various precautions taken, the engines of the generating station are so powerful that they shake the observatory. The delicate observations for nadir, which furnish the refer-



ence points for Greenwich time and for terrestrial longitudes, indicate a state of constant vibration while the engines are running, which will be greatly increased if the full proposals of the London County Council are carried out. By the invitation of the Astronomer Royal, I paid a special visit to Greenwich on Tuesday and was able to compare for myself the state of matters during the running of the engines and after they had been stopped (*i. e.*, after midnight). The observations left no room for doubt as to the seriousness of the disturbance."

*Nature* states that Messrs. R. B. Woosnam, D. Carruthers and A. F. R. Wollaston, three members of the zoological expedition sent to Africa under the auspices of the Natural History Museum, South Kensington, have made the following ascents in the Ruwenzori range. On April 1 they ascended Duwoni, the peak rising to the northeast of the Mubuku Glacier. This peak has two tops of apparently equal altitude; the southern top, which was reached, was found to be 15,893 feet. On April 3 they ascended Kiyanja, the peak at the western end of the Mubuku group of peaks. The altitude was found to be 16,379 feet. (The altitudes were taken by aneroid and by the boiling-point thermometer.) Both these peaks have been thought by different explorers to be the highest points in Ruwenzori, but from the summit of Kiyanja a still higher peak with two tops was seen in a northwesterly direction. The weather at this season of the year is very unfavorable, the mountains being almost constantly buried in clouds with frequent snowstorms, which prevented the party from making further explorations.

THE advance made during the last five years in the manufacture of various forms of apparatus for lighting purposes has developed a use for metals and metallic oxides such as tantalum, cadmium, zirconia, thoria, yttria, and cerium, lanthanum and didymium oxides. With the exception of cadmium, all these materials are now used commercially in the manufacture of different lamps and are obtained from the following minerals: monazite, zircon, gadolinite, columbite and tantalite. A

brief report on the production of these minerals during 1905 has been written by Dr. Joseph Hyde Pratt and will be published in the forthcoming volume of the U. S. Geological Survey, entitled 'Mineral Resources of the United States, 1905.' Monazite is the mineral which contains the oxides used in the manufacture of mantles for the Welsbach and other incandescent gaslights. Although monazite has been found sparingly at many localities throughout the United States, the Carolinas are still the only states that are producing this mineral commercially. During 1905, however, a probable new source of supply of this mineral has been worked out by the investigations that have been carried on at the concentrating plant of the United States Geological Survey at Portland, Ore., which has been testing systematically the black sands of the Pacific slope as to their mineralogical contents. The results of this investigation have shown the presence of some monazite and more zircon in many of these sands, especially in those from Oregon and Idaho. By using the Wetherill magnetic separator an almost perfect separation can be made of both the zircon and the monazite. The production of monazite, zircon and columbite during 1905 amounted to 1,352,418 pounds, valued at \$163,908, as compared with 745,999 pounds, valued at \$85,038 in 1904, an increase of 606,419 pounds in quantity and of \$78,870 in value. From one sixth to one fourth of the monazite mined in 1905 was exported to Germany.

#### UNIVERSITY AND EDUCATIONAL NEWS.

At the commencement of Brown University it was announced that \$162,000 had been subscribed for the John Hay memorial library, thus securing the additional gift of \$150,000 by Mr. Andrew Carnegie.

MR. D. W. GOODSPEED, secretary of the board of trustees of the University of Chicago, has announced a gift of \$260,000 from Mr. John D. Rockefeller for current expenses for the year beginning July 1.

At the recent commencement of Olivet College gifts aggregating \$265,000 were an-

nounced. Of this amount \$215,000 applies toward the Carnegie endowment, leaving only \$35,000 to be raised to ensure receiving Mr. Carnegie's gift of \$250,000.

By the will of the late Professor George A. Wentworth, of Phillips Exeter Academy, \$10,000 is bequeathed to the academy.

THE New York *Evening Post* states that Sir William Macdonald has completed his arrangements for transferring to the governors of McGill University all the property of the new Macdonald College at St. Anne de Bellevue, near Montreal, valued at between \$2,000,000 and \$3,000,000. It is the founder's wish that Macdonald College shall rank as a college of McGill University. The funds, apart from the lands and buildings, amount to \$2,000,000.

LIVERPOOL UNIVERSITY has formally accepted from Miss Isabella Gregson, of Bournemouth, formerly of Liverpool, the gift of the Gregson Memorial Institute and Museum situated in Garmoye street. The gift is to be utilized for university extension purposes, and represents in money value, with an endowment of £5,000 added by the foundress, about £300,000.

THE Goldwin Smith Hall of Humanities of Cornell University was dedicated in connection with the recent commencement exercises. Professor Goldwin Smith, who is in his eighty-third year, made one of the addresses.

THE University of Greifswald will celebrate in August the four hundred and fiftieth anniversary of its foundation.

THE University of California announces the establishment of two Flood fellowships in economics, of an annual value of four hundred dollars each. These fellowships are open to all properly qualified university graduates wishing to engage in economic study and research at the University of California.

By vote of the president and fellows, confirmed by the board of overseers on June 13, the ninth statute of Harvard University has been amended as follows: For the degree of 'civil engineer' is substituted the degree of 'bachelor in civil engineering'; the following new degrees are established: bachelor in mechanical engineering, bachelor in electrical

engineering, bachelor in architecture, bachelor in landscape architecture, master of science in forestry, master of science in chemistry, master of science in physics, master of science in zoology, master of science in geology.

THE daily papers state that Professor George E. Fellows, of the University of Maine, has been offered the presidency of the Pennsylvania State College.

AT Cornell University, Mr. E. E. Haskell, chief engineer of the U. S. Lake Survey, has been elected director of the College of Civil Engineering. Professor T. Littleton Lyon, of the University of Nebraska, has been elected to a chair of agriculture in the experiment station. Dr. W. W. Rowlee has been promoted to a full professorship of botany.

DR. GEORGE BLUMER has been appointed to the chair of the theory and practise of medicine in Yale University to succeed the late Dr. John S. Ely. Dr. Blumer was formerly director of the Bender laboratory at Albany, and professor of pathology at the Albany Medical College, and was subsequently professor in the medical department of the University of California.

IN the botanical department of the Ohio State University the following new appointments have been made: Robert F. Griggs has been promoted from fellow to assistant professor; Miss Freda Detmers, recently acting as assistant, in place of Walter Fischer, who resigned to take up work in the United States Department of Agriculture, has been made instructor in botany; Miss Opal I. Tillman, fellow in botany, resigned to accept a position as teacher of botany in the University of Arizona, and as her successor for the year 1906-7 Mr. L. A. Hawkins, of Iowa, was appointed.

DR. E. VON DRYGALSKI, of Berlin, has accepted a call to a newly-established chair of geography at Munich.

PROFESSOR WALTER NERNST has been offered the chair of physical chemistry at Leipzig, vacant by the retirement of Professor Wilhelm Ostwald, but has decided to remain at Berlin.



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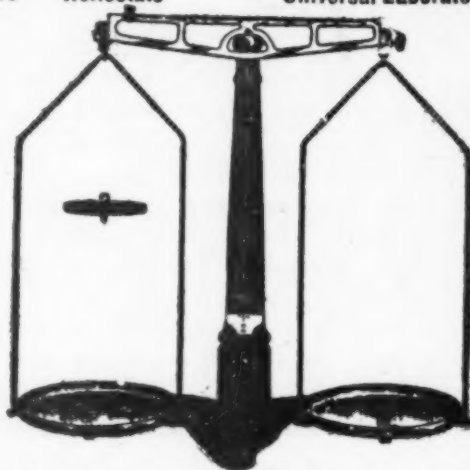
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


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